

THE PSYCHOLOGICAL BULLETIN

PSYCHOLOGY IN GERMANY AND AUSTRIA *

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The National Socialist revolution marks an epoch in the development of many German institutions, and affords occasion to review psychological thought. Attention will be given first to the major emphases current before Hitler, then to changes apparent in the first German Congress after the Nazi dictatorship was established. In the year before the Revolution (1931-1932) the writer spent a semester of study in Berlin, and one in Vienna, visiting five other universities for shorter periods. To supplement personal impressions, two more objective investigations were made. One consisted of a letter to leading younger psychologists, asking them to nominate the recent studies which they felt to be of outstanding quality and influence; the second was an analysis of papers offered by Germans at the International Congress of Psychology in Copenhagen, August, 1932. Before proceeding to the general characterization of German psychology, the method and results of these two supplementary studies may be briefly sketched.

Seventeen psychologists, whose major works lie in the near future rather than in the past, were selected from fifteen different institutions and invited to list the ten studies published within the last ten years which they regarded as pioneer works, original in ideas or method, leading into new types of research, and likely to be of most influence upon their own thinking, personally. One refused, because he could see in such a request only a typical Ameri-

* This article was, originally, a report to the American Psychological Association meeting at Ithaca, September, 1932. The vital changes introduced by the Hitler regime during the interim before publication required the addition of the last few pages concerned with more recent developments.

can scheme to apportion scientific glory by counting votes. All but two others eventually coöperated and furnished 140 nominations. These are listed in the bibliography at the close of this article. The first list contains studies nominated by psychologists from three or more different institutions. While other publications may exceed these in merit, these may be said to be among the best known, most widely recognized, outstanding contributions to psychology from the German point of view in recent years. The remaining nominations have been classified as (II) Gestalt studies, (III) Character, Typology, (IV) Psychotherapy, Psychiatry, (V) Child, Adolescent, Educational Psychology, (VI) Psychotechnical and Industrial, (VII) Theoretical and Philosophical. The frequency of these categories in the total of 140 nominations was as follows:

TABLE I
RELATIVE FREQUENCY OF TYPES OF RESEARCH NOMINATED BY YOUNGER
PSYCHOLOGISTS

Type	Per cent of Nominations
II. Gestalt studies	40
III. Characterology, Typology	19
IV. Psychotherapy, Psychiatry	13
V. Childhood, Adolescence, Education	15
VI. Psychotechnical, Industrial	6
VII. Theoretical, Philosophical	8

It should be noted that the selection of the list was somewhat influenced by the fact that the original request emphasized experimental research, with as much quantitative analysis as possible. This limitation was distinctly uncongenial to the German psychologists. Several answered that they could name quantitative studies if we insisted but that these would certainly not be the important or influential ones in their own thinking. Others simply ignored this phase of the request. Of the 140 nominations, 40 per cent were purely theoretical or viewpoint contributions with no significant experimental results involved. Another 40 per cent combined theory and experiment in so intimately related a fashion that the experiments apart from the theoretical analysis and interpretation would have little significance. Only 14 per cent were experimental studies which, in and of themselves apart from a particular line of theory, could be said to be significant. The remaining 6 per cent were summaries and pedagogically well organized presentations of the results obtained by others.

The first section of the bibliography, containing studies named

by psychologists from several different institutions, deserves special comment. Most of the studies are probably well known in America, but a word of characterization may be of value in recalling to mind the major line of contribution in each study. They are listed alphabetically.

Charlotte Bühler's *Kindheit und Jugend* represents a developmental point of view. The aim of the many studies here summarized was not to analyze individual differences, to measure intelligence, and the like, but rather to chart the steps or phases through which every human being develops: first the bud, then the flower, then the fruit. Some children may develop more rapidly than others, but that is not, for this study, important. What is sought here is the order of progression, the sequence.

Karl Bühler's *Krise der Psychologie* represented an attempt by the president (at that time) of the German Psychological Congress to describe, to compare, to criticize, and to synthesize the streams of thought underlying psychological work today. Its value to one psychologist may be reported in his words, "I think Bühler is the only one among the experimental psychologists of Germany who, despite his own researches and his own 'axiomatic', has not lost his vision of the whole".

Freud's contributions are so often mentioned by psychologists the world over that, if they were really read by the many who discuss them, they would need no comment. Some psychologists in mentioning Freud stressed the value of his method: prolonged, intensive, complete study of single individuals under exceptionally favorable conditions. Another psychologist wrote, "Freud was the first to justify the use of the term 'science' in relation to psychology, for he was the first to present a system of meaningful laws regarding the human mind, and was able further to show that his concepts were fruitful in practice".

The importance of the work of Gelb, Goldstein, and their collaborators has been in pointing the way to new ways of thinking about perception. They studied veterans with cerebral injuries, and made careful experimental analyses of what a few interesting cases could and could not do. Simple connection theories are shown to be far from adequate to explain the resulting phenomena. Gestalt organization, with something like the internal potential fields which Köhler has postulated, seems the best explanation. Cases include men with unimpaired vision but with loss of ability to grasp visual form; with sensitiveness to touch but inability to locate a pressure

on the surface of the body; with ability to "see" parts of familiar forms in areas of the retina where vision was so injured that isolated forms could not be seen; with displacement of apparent visual localization in a way that indicated the impaired visual field must be organized about a high point of attention much as the normal field is; with distortion of the perception of color such that all colors had depth and seemed to extend out from the colored object, the deeper the color the greater the extension.

The work which Jaensch did on the eidetic phenomenon is probably better known in America than is the typology which has absorbed his attention and that of his students in more recent years. Close to the eidetic group stand the "integrated" types, those whose perception is largely influenced by the components from within, who are imaginative, suggestible, lively, synaesthetic, etc. At the other extreme are the "disintegrated" who see the world as it is, reproduce faithfully, clearly, without illusion. Personality differences of great significance for vocational, national, and religious outlook, seem to Jaensch to be demonstrable also in simple laboratory tests.

Kretschmer's really astounding leap of imagination in linking together such apparently unconnected factors as skeletal build and the type of mental disorder has found statistical confirmation not only in his own work but in a flood of subsequent studies. The following table summarizes work in scores of institutions and covers about 8,000 cases:

TABLE II
MENTAL DISORDER AND TYPE OF BODY BUILD

Body Build	Schizophrenic 5,233 cases	Cyclic 1,361 cases	Epileptic 1,505 cases
Leptosome.....	50%	19%	25%
Pyknic.....	14%	65%	6%
Athletic.....	17%	7%	29%
Dysplastic.....	11%	1%	30%
Unclassified.....	8%	8%	10%
	100%	100%	100%

The contributions of Kroh and Pfahler may be mentioned together. Both have been concerned with a way of psychological thinking which is rare in America, the typological. Kroh and his students performed a variety of laboratory tests, sorting the subjects afterward not into a continuous series but into contrasting types. Thus there were those who reacted more to color than form, those who reacted more to form than to color. Similarly those in whom association was stronger than perseverative learning were compared

with the reverse type. Those who could do two things at once were compared with those who were much distracted by the combined task. Those with narrow attention span were compared with the group of wider attention span. All these characteristics were compared with self-descriptions corresponding in some degree to Kretschmer's schizothymic and cyclothymic temperaments, and significant correlations found. Pfahler, a one-time student of Kroh's, has tried to bring together the many typological systems of Spranger, Dilthey, Kretschmer, Jaensch, Kroh, etc., into one twelve-fold scheme in which the variables are (1) attention type, (2) optimism-pessimism, (3) activity.

The old philosophy of a rigid determinism and conservation of energy in the external physical world, and a similar determinism within the inner psychological experience of man, left two interesting gateways. One was that through which the events of the external world seemed to impinge on the psychic world, the gateway of perception. That Wertheimer and Köhler, who have done such creative work on this problem, are not in the list of most frequent mention is due undoubtedly to the fact that the original contributions in this field lie more than ten years back. More recently Lewin has concerned himself with the other gateway, the place where the desires and volition of the individual seem to impinge upon the external world. There is no set of studies in modern German psychology followed with more interest than is the work of Lewin. Lewin tried not to explain behavior in terms of hypothetical "causes", but rather to describe it as accurately as the astronomer may describe the relation of his observations so that the descriptions come eventually to be accepted as sufficient causation. Lewin's basic mathematics has not been quantitative but of the typological, directive, vector sort. Some would regard as most significant his various experimental demonstrations that, *e.g.*, unfinished tasks are better remembered than finished ones, that repeated acts become distasteful in proportion as they were affect-charged (either positively or negatively) in the beginning, that an act which is repeated changes its form, shifts into new parts and wholes. Lewin would regard the experiments as integral steps in building a method and theory of psychological analysis and description, according to Gestalt principles, and designed to enable understanding of individual behavior in defined situations, as contrasted with statistical or group predictions.

Selz represents the best known contribution to the psychology of

thinking. His work preceded much of the Gestalt development, and could perhaps be better defined today with the aid of some Gestalt concepts. His experiments consisted of simple tasks set to his subjects, and his analysis was a detailed description of their introspective reports of the ideas which occurred to them, the steps of solution, etc. His contribution is generally regarded now as lying more in making unacceptable the then current explanations of thought in terms of random reactions bound together by laws of association, than in his formal constructive attempts.

William Stern, whose Institute at Hamburg embraced a wide variety of psychological investigations,—child psychology, psychotechnics, psychology applied to education, psychology of perception, psychology in judicial action, and many other themes,—is represented here by his philosophical volumes on "Personalismus", and his application of that viewpoint in psychology, under the title "Personalistik". To escape from the old dualism of mind and matter Stern chose a new unit, the person, who is neither mind nor matter but an indissoluble unity. The person is not necessarily human, but may be any organismic unit in which many parts are coördinated toward a single goal. Personalism takes as its frame of reference not the physical dimensions but the personality. "Here" and "now", "before" and "after", "near" and "far", are not terms definable in physical units; they have meaning only when understood in reference to the person using them.

To comment on each of the remaining references would unduly extend this report. Rather, we shall comment on some general features of each remaining section. In the section on Gestalt, the work of Wertheimer, Köhler, von Hornbostel, Duncker, Kopfermann, Liebmann, Ternus, and Koffka belong together in a common viewpoint. The Leipzig school of Gestalt, here represented by the several volumes edited by Krueger, and also by Sander's review, differs primarily in being less monistic; they find Gestalten not throughout the universe but only as a unique feature of psychic life. Werner's work is closely interwoven with Stern's viewpoint, in which Gestalten are themselves only parts in the true whole, the unit of personal being. The Bethe-Bergmann volumes bring together (for those who can afford some \$20 per volume) an enormous mass of evidence on the integrative action of the nervous system.

Of particular interest in the child and educational psychology group are the ingenious demonstrations by von Bracken that rating scales tell less than case studies; the several Hamburg summaries

(Muchow, Stern, Werner); and Spranger's treatment of adolescence as a transition from an old to a new culture, rather than as primarily a glandular problem.

The list on abnormal psychology and psychiatry from many points of view is the most stimulating and suggestive part of the total bibliography. That the viewpoint is somewhat different from that of the rest of the bibliography will be apparent in the quotation from one exceedingly competent man who made several of the nominations: "Within the last ten years, in my opinion, no experimental or quantitative study has appeared in German psychology which has any particular merit. In the interests of scientific progress I hope that the many publications of, for example, the Gestalt theory school, or the school of Eric Jaensch will not be looked upon in the United States as representative of progress in our science." Nowhere does the complex integrative operation which seems so simple when running smoothly appear more bewildering than in the attempt really to understand what is going on in schizophrenia (Kronfeld, Mayer-Gross, Schneider, etc.), or even in a phenomenon like the mescaline intoxication (Beringer). Hartmann's book can be recommended to those interested in discovering how good a defense can be made by a thoughtful analyst for the basic approach and principles of psychoanalysis as a science. Through much of the modern psychiatric thought in Germany, however, there flows a stream of influence from Kierkegaard, Heidegger, and Jaspers, which rejects the attempt to explain psychopathic phenomena for the effort to understand them. Not prediction from "determiners" but insight into the quality and meaning of the total experience is sought.

The characterological references will probably strike most American psychologists as hopelessly speculative and armchair theorizing. One German writes, "The anti-intellectualistic position of Klages is a very healthy corrective for the ghastly intellectualism that has increasingly dominated psychology". (It is possible that such a corrective is even more needed in American psychology than in German.) Kronfeld's book gives an excellent summary of the whole field, but by no means the least of his contributions is made near the beginning of his volume where he shows how the intuitive grasp of the characterologist and the measurement by objective tests must always supplement and complete one another. If, as he says, every maker of test or rating scale begins with some sort of characterology, intuitively arrived at, it does not help matters much to be disdainful of the examination of those initial assumptions.

The interest in a sounder characterology permeates also the psycho-technical field. One of the outstanding leaders in the application of psychology to vocational guidance and industrial problems wrote, in connection with his recommendations: "There is a tendency for our investigations to be narrow and lacking in any general or inclusive idea. Much that is in itself worth while stands simply alongside other studies. The quantitative has been too much emphasized. What we need is a grasp of the worker's personality as a whole, his behavior qualitatively and psychologically understood. . . . The goal and center of every psychological research seems to me to be the problem of the individual personality in its relation to the inner world and the surrounding world, as contrasted with the efforts of the psychology of elements, or Gestalten, or consciousness, which regards itself as capable of studying psychic phenomena detached from their significance in the structure of personality. Such a psychology of the structure of personality as seems to me needed, will rest upon typological methods of research, uniting the characterological and the classificatory approaches." The studies by Jaensch, Katzenstein, and Lersmacher seem especially valuable attempts in this direction.

A little more insight into the considerations behind the list of nominated researches may be gained from a brief summary of some of the comments which the psychologists made to explain their nominations. Many protested the difficulty of the task, and maintained their own limited competence to judge and select. Many gave first place to the products of the school with which they themselves were associated but, as one remarked, "The emphasis given to my own teachers is easily explained; one values most that which one really understands". In general, this tendency to nominate writings from one's own school was not so strong as many would anticipate. There was a curious tendency for each to feel that he, almost alone of the German psychologists, was rather eclectic in his appreciations, while students of other schools had only one viewpoint. Table III shows by schools the extent of the tendency to make recommendations from within their own group.

Among the reasons mentioned for various nominations were the following:

1. Because the point of view is important:

"More because of the way of looking at problems than because of the experimental results."

"Fundamental explanations and clarifications are made."

- "Seems to see the whole range of theoretical implications."
 "Unites the point of view of the natural sciences toward reality with the point of view of the cultural sciences toward ideals."
 "Represents a point of view which cannot be neglected."
2. Because new problems are being opened up:
 "A new way of stating questions has led to new types of experiment."
 "Many stimuli for productive application."
 "The consequences of this line of thought have not yet been worked out for child psychology."
 "Brought forward problems previously neglected."
3. Because of personal influence:
 "These have influenced and are influencing my own work."
 "My own mental and spiritual development is deeply indebted to it."
4. Because of quality of the work:
 "The concepts are sharply formulated."
 "Evidences a fine and sensitive psychological discrimination."
 "Great improvement on previous methodology in this field."
 "Excellent mental gymnastics, because he takes his theory in earnest and works out its consequences to the very end."
5. Others:
 "Far ahead of his time."
 "Has the courage to apply the theory to problems outside of the laboratory."
 "Fine collection of data."
 "Based on broad experience."
 "Shows possibility of coöperation with other professions."

TABLE III

EXTENT TO WHICH RECOMMENDATIONS CAME FROM OWN SCHOOL

School	Per cent from Same School	Per cent from Same Community but Not Same School	Per cent from Outside Schools
Berlin-Frankfurt	50	15	35
Vienna-Elbing	28	28	44
Leipzig-Giessen	75	..	25
Hamburg	33	..	67
Marburg-Rheinischen Arbeitspsy.	34	6	60
Psychiatric Department, Berlin	50	..	50
Pedagogical Academy, Frankfurt	36	..	64
All	42	11	47

The second source of quantitative material to guide us in appraising pre-revolutionary emphases in German psychology is found in a tabulation of papers presented at the International Congress of Psychology in Copenhagen, August, 1932. The following analyses of papers by method followed and principal content was made in

large measure jointly, in coöperation with a young psychologist from one of the German Universities. Papers from Austria, Germany, Switzerland, Sweden, Norway, Hungary (also one from Koffka's laboratory) were grouped with the German, since they were presented in German and showed the evidence of coherence with the German points of view.

TABLE IV

ANALYSIS OF PAPERS PRESENTED TO INTERNATIONAL CONGRESS OF PSYCHOLOGY,
COPENHAGEN, AUGUST, 1932

	Germany	United States	Others	All
Number	54	40	54	148
<i>Classified According to Method</i>				
	Per cent	Per cent	Per cent	Per cent
Theoretical	43	15	43	35
Experimental	22	38	17	24
Observation, Case Study	20	13	7	14
Statistical	9	18	13	13
Tests	2	18	17	12
Historical, Biographical	4	0	4	3

Classified According to Content

General, historical	13	5	11	10
Sensation, perception	17	10	9	12
Feeling, emotion, aesthetics	7	10	4	7
Attention, memory, thought, meaning of intelligence	9	3	11	8
Motor phenomena, speech	2	8	9	6
Abnormal, nervous system	11	15	11	12
Social, religious, industrial	13	10	13	12
Personality, character	9	5	9	8
Childhood, adolescence	9	15	9	11
Learning, conditioning, habit	9	10	4	7
Individual and group differences	0	10	9	6

It is probably characteristic of any congress of scientific specialists that most of the reports seem to deal with very limited, technical questions, the application of which in life is not immediately apparent. A count of the papers which dealt with some life-centered problem, which would arouse interest in the man or woman not concerned with psychology as a scientific system, showed 7 per cent of the papers from Germany, 5 per cent of those from the United States, and 7 per cent of those from other countries belonging in this "obviously important" category. It would not be true, therefore, to say that the Congress showed the German work to be less closely linked with present life needs than were the reports from America. The above tables do demonstrate, however, that theorizing, speculating, thinking, philosophizing, system-making, were almost three

times as common among the German papers as among those from our country. Definite experiments, tests, and statistical studies had a similar predominance in the American work. The themes dealt with did not differ so significantly. The German papers showed a little more attention to general systematic problems, to sensation and perception, to attention, memory, thought and intelligence, to personality and character structure. The papers from the United States were more concerned than were the German papers with white rats, with motor reactions, abnormal psychology and the nervous system, with childhood and adolescence, and with individual differences. In the light of later political developments it is amazing that scarcely a single study touched on the economic and political forces which were molding a new order in Central Europe. The emphases in German psychology during the years when social democracy was passing may be summarized along eight related lines. Whether or not they continue in the New Germany, they are important as contrasts to typical American psychological studies. If German psychologists cease to carry forward these emphases in their laboratories, the torch may be flung to workers in other countries.

1. German psychology was more interested in thinking than in the accumulation of facts. As Köhler once remarked, "The successful psychologist in Germany becomes a philosopher; in America the successful psychologist becomes a college administrator". The contrast must not, of course, be interpreted to mean that Germans think without data or that Americans experiment without thinking, but the trend is clearly different in the two branches of the psychological stream. It was educative to report the facts of an American study to a German seminar, only to be asked: "Yes, and what of it? What does it mean?"

2. German psychology has been more interested in qualitative descriptions than in objective scores. Two subjects score alike, for example, on a certain coöperation test. One, however, has made his score in a quite different way from the other; he has been more careless, indifferent to the whole business, lazy, and turned with vigor to something else when released. The other approached his task cautiously, calculated the advantages for himself, worked out his responses meticulously, sat thinking over his work when he had finished, wondered if he ought not to ask for it back again to make some correction. These differences do not appear in the common score. But these are of great interest to German psychologists.

3. German psychology was more interested in psychological than

in physical controls. A situation that is objectively constant; same room, same apparatus, same hour of day, etc., is regarded as desirable by more American experimenters. From many points of view in Germany, such a situation is not constant. When five children alike in age and I.Q. are introduced to it, there still may be five different psychological situations. Inconsistency and specificity such as Hartshorne and May found is the inevitable result of an attempt to understand only the externals of the situation.

4. German psychology was predominantly concerned with wholes and relationships. One psychologist wrote, "The most important problem in my list is probably that of the whole brought forward by Wertheimer, best seen in its theoretical implications by Köhler, courageously applied by Gelb and Goldstein on the one hand and by Lewin on the other, to problems which are vital for human life outside of laboratories". Even Gestalten, however, are not inclusive enough to suit German workers who would like to consider the Gestalt, also, not as an independent element, but as a particular level of unity within a hierarchy of "persons" which may be as small as a cell or as great as the universe.

5. German psychology showed more concern about understanding a single case than about the probabilities in a group. A correlation of .80 is psychologically unsatisfactory, until the exceptions are understood, analyzed, and accounted for. After all, if we are dealing with natural laws, those laws must hold in every individual case. They are absolute, not mere statistical trends. The typical German dissertation, therefore, showed prolonged analysis of relatively few subjects. A series of different experiments was performed on these subjects, modifying the procedure this way and that, until the writer felt that he understood what had happened, psychologically. No detail is unimportant. No exception may remain unaccounted for. Our typical American dissertation in which one single procedure is carried out with large numbers of cases and then treated statistically, seems to them to fall short of any genuine psychological contribution.

6. German psychology sees individual trait differences as consequences of more basic type differences. They are less concerned with what the subject can do on intelligence or achievement tests, but relatively more concerned with how these reflect his *Weltanschauung*. Even in psychotechnics we find the question shifting from "What are his special abilities?" to "What kind of a person is he?" When we talk of individual differences we like to use units of a measuring scale. German psychologists are apt to use such measures only as

intermediary steps toward the goal of describing the individual as belonging to a type. Typology has the disadvantage of exaggerating the differences within the great mass who belong near the middle of the scale, but the advantage of being striking and clear in meaning. It implies truly that traits do not vary in isolation.

German psychology assumed a greater unity in the individual personality than it is customary to assume in the United States. Hence handwriting and gestures were regarded as bound up with the personality in such a way that no kind of person except this one kind could make this particular sort of gesture or normal handwriting. Similarly various literary products, diaries, letters, even questionnaire answers, are not regarded as more or less detachable reactions to the particular stimulating situation, but are seen also as expressions of *the* personality concerned. This person and this alone, being the kind of person he is, could have written this work. If we really understood the work we would know the person in his entirety. As a consequence of this point of view, the relation of personality to physique, to motor expression, and to intellectual productions of all sorts has been more investigated by German psychologists than by our own group.

7. German psychology has been more concerned with insight than with prediction. One aim of science is to predict from situation "a", the succeeding state of affairs "b". This aim seems to be more characteristic of American than of German work. Another possible aim is to understand a situation by seeing it in its necessary relationship to a larger whole. In this sense we understand the detail of a picture or a passage in a symphony. This attempt to grasp significance seems less evident in our work in the United States.

8. German psychology has been more systematic. Each Institute has preserved its own schematic and has guided research within that framework. As a result, each German University department has its clearly defined character. Lecturers as a rule pay less attention to other "schools" and their experiments than we would expect from a teacher, whatever his personal system of psychology. Facts with us often become ends in themselves; in German laboratories they are stones in a clearly outlined structure.

What has happened to this culture stream during the exciting events of the past year or two? It is too early to tell the whole story.

The writer was privileged to attend the Thirteenth Congress of the German Psychological Association which met at Leipzig in

October, 1933. This was the first gathering after the Nazi revolution. Some 600 psychologists attended the meetings.

The first change noted was the absence of some of the most distinguished leaders: Wertheimer, Stern, Katz, Peters, Koffka, Kronfeld, Lewin, and many others. Indeed, the officers of the Association had been non-Aryan, and were replaced by lesser scholars of correct heritage. Personal investigation indicated that the great tragedies of National Socialism were less in the occasional atrocities played up by the press than in the silent suffering of men who had given a lifetime of worthy service, suddenly forced to withdraw, to see their contributions scorned, their journals discontinued, their institutes dismantled or "reorganized". Incidentally, psychoanalysis as a "Jewish doctrine" has been practically banished.

TABLE V

THEMES DISCUSSED—13TH CONGRESS, GERMAN PSYCHOLOGICAL ASSOCIATION

Theme	Number of Papers
Perception, Gestalt concepts, structure of consciousness, experience of space, time, etc.	12
Typology, characterology, study of expression.....	11
Psychotechnics, vocational guidance, psychology of work, tests (only one report on tests).....	7
Motivation, ideals, interests, morality.....	5
Developmental, childhood and adolescence.....	3
Social relations, popularity, leadership.....	3
Language, speech, reading.....	3
Special abilities, drawing, etc.	2
Anthropological, ethnological.....	2
Physiological.....	2
Animal.....	2
Learning.....	1
Heredity.....	1

Equally striking was another change: the "politicalization" of psychology. Krueger expressed, in the opening presidential address, his faith in idealism, particularly the new German idealism. Poppelreuter was the most politically active of the group. He has been teaching "political psychology" using Hitler's "Mein Kampf" as his text. Jaensch bent his typology to show that the enemy (Jews and Parisians) were S type: destructive, lytic, disintegrative, so adaptable as to lack all inner character structure.* Studies by Clauss and the Prince of Isenburg also emphasized racial character types. Pfahler, in discussion, urged that the psychologically undesirable type, rather than certain racial stock, be the subject of attack. He

* It was distressing to learn that Jaensch had recently stooped to political attacks upon Köhler because of the latter's international contacts.

recognized that there might be those of his own race, biologically, who could not enter with enthusiasm into the Nazi ideology, while some of non-Aryan ancestry might be psychologically harmonious with the new.

The sectional meetings, at which research reports were given, showed the emphases continuing much as in pre-Hitler years. Table V shows the themes discussed.

From a methodological point of view the studies may be classified as follows:

TABLE VI

PRIMARY METHOD UPON WHICH CONTRIBUTION WAS BASED—13TH CONGRESS, GERMAN PSYCHOLOGICAL ASSOCIATION

Experimental	22
Questionnaires	5
Theoretical discussions	30

The following gives a brief review of some specific contributions especially likely to be of interest to American workers:*

Giese (Stuttgart) found that the changes in circulation accompanying conscious effort, emotion or relaxation changed the distribution of heat radiation from the body.

Rohracher (Innsbruck) placed a coil of carefully insulated wire about the head; used a four-stage amplifier and, on an oscillograph, recorded curves clearly affected by induction through mental effort.

Strehle (Kassel) elaborated the theories of Piderit and Darwin on human expression, showing that faces and postures of rejection, defiance, resignation and even smiling were related to primitively useful muscular reactions, not to the identical situation but to one with similar affective tone. Unpleasant reactions show a "spit-it-out" mouth; pleasant ones a "sugar-in-the-mouth" form.

Von Bracken (Braunschweig) studied the reaction of twins to each other, and among 15 pairs of identical twins he found more tendency to be together, less quarreling, more sharing in joys and sorrows, more similarity of playmates, games, interests, appetite, etc., than in 11 pairs of fraternal twins. He concludes therefore that similarity of psychological environment as well as of heredity is greater for the identical twins, and their greater resemblance to each other must not be attributed wholly to the germ cells.

Kroh (Tübingen) found that when both parents showed a predominance of form-determined over color-determined reactions or

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vice versa, children followed the parental type in 85 per cent of more than a thousand cases.

Köhler (Berlin) reported the results which he presented at Chicago recently, showing that the nonsense syllable or figure or number pair which is placed in a row of other pairs of the same general sort merges into the background and becomes indistinct; whereas in a different setting it would stand out and be quickly learned. Inhibition comes from similar material either before or after the pair in question.

Rombach (Freiburg i. Br.) showed that children learning to read by a "whole word" method tend to identify the configuration of the word directly with the object, and not with the sound of the word.

Wittmann (Kiel) has been interested for some years in the auditory "shape" of words. Comparing terms in Indo-Germanic, Bantu, Turkish, Samoan and other distinct languages, he found similarities in the physiognomy of word and objects. Subjects asked to choose among suggested nonsense names for figures of various sorts showed similar Gestalt-matching tendencies, emphasizing similarity of shape, rhythm, contrast, fluidity, compactness, length, firmness, monotony, sharpness, fullness, interruptedness, etc.

Hetzer (Elbing) showed that children doing outline drawing, given an exercise which stimulates the use of color imagination (a dragon with patches of many colors), show marked progress as compared with control groups in the development of a synthesized color and form in later drawings. Here again the Bühler sequence from pure function to organized work may be observed.

Bonte (Hamburg) found that eidetics of the B type were distinguished by better imaginative drawings, but were not superior in drawing from model or memory.

Gottschaldt (Bonn) observed the stages of a group of adolescent girl psychopaths, from the original clique enthusiasm through gradual disintegration, attempts to keep the club alive, bring in new blood, new programs, etc., and concludes that freedom for inner and outer separation from the group is essential for its continuance.

Schmeing (Berlin) studied the negative ideals of pupils, the persons they would most hate to resemble, in contrast to their positive hero-choices.

Zillig (Würzburg) found that the best-liked children in the class tended to come from better social status, to win more approval from the teacher, to have been in the class for more years, to be slightly

more intelligent and very much more attractive in person, dress and manner.

Sander (Giessen) demonstrated a machine which gradually transformed clicks of one rhythm into another rhythm and allowed a charting out of the times during which the sounds were disintegrated, appearing to be organized, clearly in a given form, becoming difficult to hold together, moving again into chaos, reappearing in a new Gestalt, etc.

The eight major trends previously noted continue. German psychology is still more thoughtful, more qualitative, more subjective, more concerned with wholes, more insistent on understanding the particular case, more apt to make typological and characterological studies, more interested in achieving insight, more concerned with schools and systems. Although many brilliant psychologists have left voluntarily or been forced to leave, this cultural tradition is likely to continue for many years. No one has emphasized this more strongly than Spranger, the Berlin pedagog. "Der objektiv Geist" remains relatively constant while men and parties come and go.

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- E—Elbing Pedagogical Academy.
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- G—Psychological Institute of the University of Giessen.
- H—Psychological Institute of the University of Hamburg.
- L—Psychological Institute of the University of Leipzig.
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DIURNAL VARIATIONS IN PERFORMANCE AND RELATED PHYSIOLOGICAL PROCESSES

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We are concerned here with the diurnal variations in human 'output' and 'input'. These measures are related intimately to the 'efficiency' of performance, though just how we cannot yet say. The studies covered by this review have been grouped as follows: (I) those which deal with variations in work output alone; (II) those which record only some physiological measure of organic energy expenditure (or input); (III) those which correlate output records with concurrent physiological changes at different hours; and (IV) those which deal with factors affecting the diurnal curve. It seems advisable to include in these groups only the fluctuations occurring during the day. Johnson and Swan¹ have previously surveyed the literature on nocturnal variations.

(I) STUDIES IN WORK OUTPUT

This method constitutes the most obvious approach to the problem of diurnal variations. Education and industry early saw important implications in such research, and hardly a single human activity has escaped the attempt to plot its daily course. Considering the vast amount of work done, however, the results appear to the reviewers as rather inconsequential. Investigators differ not only as to the hour of maximum output, but also as to whether the morning or afternoon period is superior. Some results indicate a gradual increase in output during the morning and a gradual decrease during the afternoon. Others show a morning drop and an afternoon rise. In still others there appears to be little noticeable change. Much of

¹ Johnson, H. M., and Swan, T. H., Sleep. *PSYCHOL. BULL.*, 1930, 27, 1-39. Cf. also Johnson, H. M., Swan, T. H., and Weigand, G. E., Sleep. *PSYCHOL. BULL.*, 1926, 23, 482-503.

the disagreement should be expected. There is no *a priori* reason to assume that periodicity in performance is determined by some mysterious force, and that it is, hence, as inevitable and as universal as the tide. Certainly we have progressed sufficiently from the astronomical interpretation of behavior to realize that diurnal variation may well be a habit phenomenon. If this turns out to be the case, the form of the diurnal curve will be determined largely by the individuals included in a given sample. This possibility seems to have occurred but seldom to the majority of investigators. The zeal to achieve a *practical* goal results in broad generalizations based on very few cases. Authors inclined to consult secondary sources only have done much to extend such dogmatism. We find, for example, the general opinion among educators that the child is most efficient during the morning and that the best time to give the supposedly most difficult subject, arithmetic, is from 10 to 12 o'clock. But the actual studies cited in support of this doctrine have been generally done under a set of conditions much different from the situation to which the results are applied.

Let us now turn to the detailed examination of our topic. For convenience we shall distinguish the studies of (a) sensory, (b) motor, and (c) higher mental processes. Mention of the actual hours when tests were conducted in all of these studies would unduly complicate our report. In general, it can be said that the usual interval is two hours, and that the remaining diurnal studies are about evenly divided in using the four-hour and the one-hour interval.

(a) *Variations in sensory acuity.* Research here takes the form of determining the limen for various types of stimulation. Marsh's (87) results, obtained from the testing of over 100 Filipinos at the St. Louis World's Fair, showed a slight afternoon superiority for visual discrimination and color matching. Auditory tests, while likewise inconclusive, favored afternoon performance. Records taken by Patrick and Gilbert (95) at six-hour intervals give some evidence of increasing visual and auditory sensitivity throughout the day.²

The aesthesiometer has been used in studying diurnal variations in skin sensitivity. Griesbach (46), Wagner (125), and Schuyten (110) report a declining sensitivity, as measured by the two-point limen test, from hour to hour, while the data of Leuba (80),

² Although Patrick and Gilbert also studied pulse, temperature, motor ability, memory, etc., no further mention need be accorded them. Theirs was not a normal situation, since the subjects were prevented from sleeping throughout the entire test (ninety hours).

Germann (44), and Martin (89) suggest improvement in sensitivity rather than decrement.

It is obvious that the above reports lend themselves to no general conclusion; four suggest increased sensitivity in the afternoon, three decreased sensitivity, and one contains both forms for different sensory functions. Close examination indicates, furthermore, that the differences either are too small to be statistically reliable or else bear out the author's assertions only in part.

(b) *Variations in muscular activity.* Diurnal measures have been made of simple movements, muscular strength, and complex motor coördinations. Reflex latency increases hourly, according to Dodge (30). Ostankow and Gran found that the morning hours also give the shortest voluntary reaction time. This, however, was contradicted by the work of Maity (86) and of Marsh (87). Another measure of the speed of simple movements is provided by the tapping test. Dresslar (31) and Marsh (87) performed experiments which showed a superior rate of tapping in the afternoon. The tests of Bergström (11) and of Dodge (30) indicated a mid-day maximum. Data compiled by Marsh (87) on Filipinos oppose Hollingworth's (62) finding on college students that the highest rate is found in the morning at the beginning of the tests.

A consideration of the maximal strength which an individual can exert at different hours leads naturally to ergography. Higher output was found in the afternoon than in the morning by Oseretzkowsky and Kraepelin (93). Lombard's (83) results, showing maximum contractions in the morning and late evening, are contradicted by those of Patrizi³ (96), who found an afternoon maximum with a decline in the evening. Powarnin (102) supports the latter. In their diurnal studies of Chicago school children, Christopher (24) and Smedley (113) report that the maximum ergographic records generally occurred early in the school day, and that a secondary rise followed the noon meal. But the studies of Buch (19), Maity (86), Harley (53), Lehmann and Pedersen (78), and Peaks (97) show, in general, better records in the afternoon. Peaks puts considerable reliance on the results of Kuhnes (72), which are very similar to his own. He says: "This work . . . is the most complete record of diurnal efficiency covering a long period of time, which has ever been made. All the data are given in complete form, and a most

³ This work has apparently been consulted in the original but seldom. At least, there is a frequent misspelling of Patrizi's name, *e.g.*, Peaks spells it Patrice (and Patrici), and Gates refers to Patrici (p. 77).

careful search fails to show any errors in the method, or in the interpretation of the results." ⁴ Examination of the original source shows that Kuhnes' curve is based upon only one individual, himself, and that the mean variations of hourly averages are twice as large as their differences, *ergo*, little better than chance. Although the tests covered five hundred and five days, only 68 per cent of the records approximated the average diurnal curve.

Storey (115, 116) obtained ergographic records which gave some indication of a progressive rise. In a third research (117) he compared involuntary movement with the voluntary movement, reporting a general similarity in their diurnal course. The involuntary movements were produced by electrical stimulation of the motor points of the arm. His results are stated as follows: "We have, then, a morning period of increasing power until ten *or* eleven o'clock, *or later*; then a fall in power until noon *or later*; then an afternoon rise until three *or* four o'clock and a fall in power being evident at six, and an evening rise from six *to* seven *or* eight o'clock, and then a fall in power from seven *or* eight until ten o'clock." ⁵ If the reader can make anything out of this remarkable bit of equivocation, the reviewers would like his help in interpreting the data upon which it is based. How general was the morning rise? How characteristic was it for the same individual upon successive days? What are the actual differences in output from hour to hour, and what is the statistical reliability of these differences? Most of this information is withheld. Except for the scattered data on himself we are only given the vaguest results. For example, we are told only that from 10 to 12 A.M. 6 trials showed a gain, 97 a loss. If the subject raised the weight ever so little higher at 12 A.M. than at 10, by this criterion his muscular strength would be said to have increased. When 50 per cent of the cases showed a gain and 50 per cent a loss, Storey concludes that there has been "no change".

Diurnal variations in complex motor coördinations have been studied in the laboratory, school, and factory. Marsh (87) obtained data with a novel tiddlywinks test which show that the greatest accuracy in muscular movement is attained around noon. Holling-

⁴ P. 54. In spite of his enthusiasm for Kuhnes' work, Peaks managed to misquote the title and year of the reference. This is by no means exceptional, since Peaks' bibliography abounds in the grossest types of error. For example, the reviewers searched in vain for Storey's article which Peaks said was in Volume 7 of the *American Boys Educational Review*, later finding it in Volume 6 of the *American Physical Education Review*.

⁵ Italics ours.

worth's (62) tests included (A) accuracy in hitting a three-hole target, (B) steadiness with which a small rod was held at arm's length, and (C) efficiency in typing. The target performance and typing showed a morning fall and an afternoon rise. Steadiness increased until late afternoon. Speed and accuracy of card sorting, according to Bergström (11) tend to show decrement in the afternoon; but Gates' (42) data on rapid maze tracing show the speed of performance greatest in the afternoon.

Speed and accuracy do not necessarily follow the same course. In fact, according to Marsh (87) and Gates (42), they pursue exactly the opposite course. Hollingworth (62), on the basis of typing records, and Kleitman (70), on the basis of a variety of tests, however, find speed of movement correlates positively with accuracy.

The factory offers an excellent place for the study of diurnal variations in highly complex motor tasks. Vernon (123), whose work includes an excellent summary of previous investigations, reports that there is no typical diurnal curve for the industrial situation; the course is determined by a large number of external factors which differ from plant to plant. He mentions three distinct types of curve, named according to the most important influence determining their shape: (A) *Fatigue curves*. Rather heavy muscular work tends to show a gradual decrement during the morning and also in the late afternoon (cf. Lee, 77). (B) *Practice curves*. Performances which become easier with practice increase in effectiveness as the morning progresses, fall off after lunch, and then show another rise till the end of the working day (cf. Florence, 36). (C) *End-spurt curves*. Factories which have a piece work system tend to have an output curve which rises distinctly in anticipation of the end of the day (cf. Link, 81). Most industrial processes, however, show a composite type of curve. For example, Marsh (87) and Burt (20) gave evidence in their records of a multiplicity of factors influencing factory output. That internal factors are as important as external factors in determining the form of diurnal curves of output is indicated by Kent's (68) study of candy-makers.

Variations in accident rate are also involved in the problem of industrial output. A statistical survey of accidents by Bogardus (16) shows that the data compiled in various countries are in agreement that the curve of accidents has a morning maximum at 10 to 11 o'clock and an afternoon maximum from 3 to 4 o'clock. These compilations have been supported by Lescotier (79) and Florence (36). Both in the industrial situation (cf. Vernon, 123, and Bogardus, 14)

and in the laboratory (cf. Bogardus, 15) it has been demonstrated that increased output is accompanied by increased inaccuracy of movement, resulting in a higher accident rate.

If any single thing stands out regarding the diurnal course of muscular work, it is the influence of environmental factors upon an individual's performance. If there is some basic organic factor which determines muscular output, it is seriously obscured by the general test-situation.

(c) *Variations in the higher mental processes.* The bulk of the vast amount of work upon this problem has been done within the school system, and frequently for an immediately practical end. It would be, one realizes, of vast importance to know how well the school child can 'give' attention at different hours of the day. But how are we to measure *attention*? Schuyten⁶(108) considered that he had an adequate method. He merely recorded the number of times a pupil raised his eyes and looked about while reading a five-minute assignment. The report shows that 'attention' was better in the morning during January, February, April, October, November, and December, but better in the afternoon during May, June and July. No difference was noted in March. Schuyten concludes from this study that attention diminishes from 8:30 to 11 o'clock in the morning and again from 2 to 4 in the afternoon. The attention is better at 2 o'clock than it is at 11, but is inferior to the early morning reading.

Using the Masson disk to measure "attention waves", Pillsbury (100) reported much individual variation but a general decrease in capacity from morning to evening. Wiersma (131) found his own 'attention' better in the late afternoon, but his other subjects show great variability. What he actually measured was the time taken before a subject ceased to discriminate between liminal lights, sounds, and pressures. Diurnal tests of discrimination have been made by Marsh (87), Muscio (91), and Gates (42). Each finds a different course.

Contradictions likewise appear between reports on color naming. For Marsh's (87) subjects color naming increased in effectiveness until about 2 in the afternoon. For Hollingworth's (62) subjects the opposite course prevailed.

⁶ This work is almost universally attributed to Lobsien (82). The error is due apparently to Marsh (87) who thought Lobsien's review of Schuyten's (108) work was the original research. Subsequent reviewers of diurnal variations, e.g., Gates (42), Peaks (97), and Kuhnes (72), have presumably never consulted the source they quote and hence the error has persisted.

Association tests present a highly variable diurnal course. Cattell (21) and Hollingworth (62) reported that the shortest association times occur in the early morning while the longest are found in the evening. Ellis and Shipe (33) and Marsh (87), however, give data which favor the afternoon hours.

There is an extensive literature on diurnal variations in memorizing. Schuyten (109) and Marsh (87) found a morning superiority. Ellis and Shipe (33) showed greater afternoon performance. Larguier des Bancelles (76) demonstrated that he could memorize material most effectively in the morning and late evening. Peaks' (97) study of memorization shows "a rise from 9 to 11 A.M., a drop from 11 A.M. to 1 P.M., a rise from 1 P.M. to 2 P.M. and a slight drop from 2 to 3 P.M. in some cases, while in others the records from 2 to 3 remain almost stationary". Gates found that the memorizing of children (42) and college students (43) (recognition of auditorily and visually presented digits and nonsense syllables) increases gradually until noon, declines until 2 P.M. and rises slightly after that time.

A very thorough study of diurnal variation in immediate memory was made by Winch (133). He used school groups of equal ability and brought them to a high practice level before making tests. One group was tested in the morning, the other in the afternoon, and then the order was reversed. The output of the morning group was nearly 6 per cent higher than that of the afternoon group in one study, and 2 per cent higher in the other. Such simple precautions as Winch used against the deleterious effects of monotony would have rendered more significant many of the researches discussed above.

Variations in arithmetic efficiency have been tested by Martin (89), Thorndike (118), Marsh (87), Rice (104), and Robinson (106). Morning hours appear more favorable. Some of these results might have been due to the testing of initially better groups in the morning. The work of Winch (134) is not open to this criticism, since he attempted to equate the initial arithmetical ability of his groups by preliminary tests. The late forenoon classes did from 5 per cent to 8 per cent better than those at other hours. Employing the Curtis arithmetic test, Heck (54, 55, 56) found a steady increase in the number of problems solved, but this was accompanied by a corresponding increase in the number of errors. Gates (42) showed a continuous increase in arithmetic output throughout the morning, followed by a drop from 1 to 2 P.M., and then by a slight rise lasting until the end of the school session.

According to Hollingworth (62) and Muscio (91), however, there is a continuous and invariable decrease in calculation ability during the day. A recent study of Stainer (114) showed that the rate of computation reaches its maximum late in the morning and then remains constant till late in the afternoon. Closely allied to these arithmetic studies are those of Robinson (106) and Thorndike (119) on spelling, which showed that performance is, generally inferior in the afternoon.

Sikorsky (112) used the method of dictation to study changes in "efficiency" and "fatigue" throughout the day. A progressive decline in errors was noted from morning till afternoon. Friedrich (38) failed to confirm his findings.

Translation tests have been studied by Marsh (87) and by Kleitman (70). The former finds a continuous increase till night, while the latter finds the maximum in mid-afternoon. With the completion test, Ebbinghaus (32) and Gates (42) obtained opposite results. Gates' (42) curve runs upward from a morning minimum to a mid-day maximum, falling after the lunch hour, and increasing again during the last hour of the school day. Gates concluded his study with a detailed comparison of the several mental functions whose diurnal course he recorded. The highest coefficient obtained for one test when compared to all others was only $+ .14$.

Hourly fluctuations in speed and accuracy of performance in mental tests have been studied by Laird (73) and Link (81). Laird (73) observed a decline until late afternoon, when an increase was noted; Link (81) found the greatest output was attained at 1 P.M. Most errors were made just before lunch and just before dinner.

Our survey of diurnal studies of mental work is not complete without some mention of the results of the questionnaire technique. Heerwagen (57) found that the majority of students prefer the morning for mental work. From 8 to 11 A.M. and from 8 to 10 P.M. were the favorite times of the students studied by Barnes (2) and O'Shea (94). Marsh (87) studied the biographies of numerous authors for clues as to their writing habits, and found that while 34 per cent preferred the morning, only 1 per cent preferred the afternoon. His questionnaire to physical directors and athletes showed that there is a marked preference for afternoon sports.

In view of the wide diversity of results obtained in diurnal studies of work output, it is fitting to inquire which investigations deserve especial consideration. Other things being equal, studies should be

TABLE I
SHOWING THE TYPES OF DIURNAL CURVES OF OUTPUT REPORTED BY VARIOUS INVESTIGATORS
(The figures in parentheses refer to the number of subjects.)
(The asterisk indicates that a measure of reliability is reported for the curve.)

	Type I The continuous rise —	Type II The continuous fall —	Type III Morning rise; afternoon fall —	Type IV Morning fall; afternoon rise —
Sensory Performance	Germann (1)* Patrick and Gilbert (3) Martin (6)* Leuba (9) Marsh (108)	Wagner (190) Griesbach (102) Schuyten (10)		
Muscular Performance	Maity (4)* Dresslar (1)* Marsh (123)* Hollingworth (16)* Oseretzkowsky and Kraepelin (1) Buch (1) Kuhnes (1)* Peaks (10) Storey (3) Storey (1) Storey (5) Ellis and Shipe (7) Gates (#) Harley (1)	Smedley (12) Christopher (1127)	Bergström (1)* Patrizi (2) Lehmann and Pedersen (1)* Hollingworth (15)* Marsh (22)* Dodge (1) Powarmin (115) Kleitman (3) Harley (1)	Lombard (1) Hollingworth (16)* Ostankow and Gran (4)
Mental Performance	Wiersma (5)* Gates (#) Gates (190) Ellis and Shipe (6) Marsh (13)* Peaks (10) Heck (1153) Heck (573) Heck (476) Sikorski (43) Martin (6)* Link (40)	Muscio (34)* Pillsbury (6) Friedrich (51) Hollingworth (25)* Cattell (2)* Schuyten (90) Marsh (8)* Winch (96)* Winch (198)* Römer (1) Thornike (771) Rice (6000)	Marsh (6)* Gates (#) Bergström (6)* Stainer (532) Kleitman (4)	Marsh (7)* Ebbinghaus (535) Peaks (10) Larguier des Bancels (1) Laird (73)*

NOTE: # = "six classes".

weighted which show fairly consistent diurnal curves for a large number of subjects. The reviewers have attempted to give in a single table the results of the numerous investigations of output changes during the day. Table I gives four types of diurnal curves: (a) the continuous rise,⁷ (b) the continuous fall, (c) the morning rise and the afternoon fall, and (d) the morning drop and afternoon rise, together with the names of the individuals reporting such curves. The fact that a name occasionally appears in two columns indicates that in two separate studies, or for two different functions, this investigator obtained two types of curves. In many cases the placement of a study is somewhat arbitrary, determined only by the fact that more cases reported follow the particular course under which it is placed. No attention can be given to the *amount* of change from hour to hour, especially since many investigators do not report actual output records. The figures appearing behind each name represent an attempt to show the number of subjects upon which the data were obtained. These numbers, of course, are not as significant as they would be if we had some measure of the variability of the scores. Only those studies which are marked by an asterisk give any such measures (M.V., S.D., or P.E.). They represent less than one-fifth of the total number of studies, and of these only a very few show a reliable difference. If we knew the mean variations of the other studies the percentage of reliable differences would be further reduced. In spite of all of these deficiencies, the balance of evidence in Table I apparently favors an afternoon superiority for sensory and motor performance, but there is little agreement as to the time when complicated mental work can be done most efficiently.

(II) STUDIES OF ORGANIC ENERGY EXPENDITURE

In many of the foregoing studies it has been assumed, explicitly or implicitly, that work output is a function of some basic physiological 'rhythm'. The argument runs that more and better work can be turned out at one time of the day than another because the human machine naturally exerts more 'energy' at such a time. Energy-expenditure and reactivity are measured most directly by the metabolic rate, but several related physiological processes have been used more generally as indicators. These include pulse rate, blood pressure, respiration, muscular tonus and temperature. The litera-

⁷ We include here also those curves which have a drop at noon but a subsequent rise.

ture here is so extensive that we will in general refer only to recent studies which usually have discussions of earlier work.

Metabolism is the best index of total reactivity which we have, since it is not greatly affected by purely local changes (Benedict, 6). But the difficulties of keeping a subject in a respiration calorimeter or a gas mask all day have prevented an exhaustive diurnal study of metabolism from being made. Benedict and Carpenter (3) made continuous measurements over considerable periods of time, and came to the conclusion that there are no marked changes taking place in metabolism. Some indication of an increasing rate of energy-exchange is given in Benedict and Joslin's (9) study in which hourly changes in insensible weight-loss were observed with the use of a delicate balance. In this connection mention should be made of Storey's (115) early observation that weight and height changes of considerable magnitude occur throughout the day. Benedict's (5) data, based on metabolism during fasting, give information concerning the form of the diurnal curve uninfluenced by the effects of food. Additional data on the diurnal course in this situation are furnished by Johansson, Landergren, Sondén, and Tigerstedt (66). They find a minimum metabolism at midnight and the maximum upon awakening in the morning. Völker (124) plots the metabolism readings with a minimum in the early morning and a maximum in the early evening, while Johansson (65) finds the maximum in the morning from 10 to 12 A.M.

The early studies of temperature variations during the day are well summarized by Tigerstedt (120) and by Piéron (99). Recent researches are reviewed by Deighton (28). Studies by Heiser and Cohen (58), Gessler (45), and Woodhead and Varrier-Jones (135) substantiate to a great extent the results of early investigators from Jürgensen (67) to Benedict and Slack (10) in the determination of a diurnal curve with an early morning minimum and a late afternoon maximum.

Hourly pulse records, obtained with the cardiometer, are given in Boas and Goldschmidt (13). The writers do not take up diurnal variations of pulse rate as independent phenomena, but discuss pulse rate during eating, work, exercise, sleep, etc. Curves based on the assumption of some immutable rhythm are no longer in vogue. Of historical interest are the results of Binet and Courtier (12) which show a maximum pulse rate after the noon meal. More reliable results are those of Benedict (5), taken by observation of resting, fasting subjects. Further discussion of pulse

rate changes will be reserved for our section on the factors influencing the form of the diurnal curves.

Diurnal changes in blood pressure have been frequently reported. The results of Weyse and Lutz (130), Weiss (128), and Hensen (60) substantiate the statement of Erlanger and Hooker (34) that "throughout the day the velocity of blood flow increases, but the gradual increase is in part obscured by waves of velocity changes induced by the ingestion of meals".

The diurnal course of phosphorus excretion and of heat production are inversely correlated, according to Kleitman's (69) results. One might also expect the acid-base condition of the body to show a decrease throughout the day; but Cullen and Earle (25) report a gradual increase in hydrogen-ion concentration (pH), interrupted by the ingestion of food and by violent exercise.

Muscular tonus may be considered an indirect measure of physiological reactivity. Lombard's (84) index of tonus-increment was the amplitude of the knee-jerk. His records show a continuous decrease from morning until night. Dodge (30), working on the same problem, reported that while amplitude tends to drop during the day, it rises during the evening. Records of eyelid reactions showed a continuous fall. More direct measures of tonus have been made by Travis (122) and by Freeman (39). Both found that tonus was highest in the late afternoon and evening, and lowest in the morning; but since many of the records were taken at long intervals they are only suggestive of the diurnal course.

There has been considerable discussion as to whether the various measures which we have so far discussed vary independently, or follow the same general course. The disagreement seems to be based on whether the writer is referring to the general diurnal course, or to the variation during specific activities. Griffith, Pucher, Brownell, Klein, and Carmer (47) find pulse and blood pressure have little relationship, while Binet and Courtier (12) find the same lack of relationship true of pulse and temperature. Johansson (65) and Völker (124), however, find that the various measures have parallel diurnal variations. Heiser and Cohen (58) have found the following correlations between bodily processes: between mouth temperature and pulse rate $-.04$, between metabolism and head temperature $+.98$, between head temperature and blood pressure $+.76$.

A remarkable agreement is found in the studies of Waller (126), Wechsler (127), and Regelsberger (103) concerning the diurnal changes in bodily resistance and polarization capacity of the skin.

The typical form of the curve shows high resistance in the morning, a fall at mid-day, then a rise, gradual at first, but becoming more pronounced toward evening. This type of curve resembles that of temperature (Darrow, 26, and Wechsler, 127). Additional studies of diurnal variations in the electrical phenomena of the skin are reviewed in Landis and DeWick (74) and Landis (75).

This is perhaps an appropriate place to examine the validity of experiments on diurnal reactivity. While often more painstakingly and better controlled than 'output' studies, they still suffer from the inclusion of too few cases. But anyone who has worked with physiological measurements realizes that it is more important to study one case well than a large number hastily. The work of Dodge (30) is a case in point. Dodge's results give a true picture of the reactivity of one individual. Whether such a curve can be called typical we cannot yet say. Certainly the amount of agreement among the studies noted above is encouraging. With a few exceptions, they have indicated a gradual increase in bodily reactivity and energy-production from morning until night.⁸

Detailed discussion of the relative merits of the several indicators,—pulse, respiration, temperature, blood pressure, tonus and metabolism,—cannot be attempted here. Each researcher has good reasons for his particular choice, and, aside from the fact that metabolism is the most direct measure of human energy-transformations, there is no general agreement as to what indicator is the best.

(III) STUDIES WHICH CORRELATE OUTPUT RECORDS WITH CONCURRENT PHYSIOLOGICAL CHANGES

Although there has been considerable discussion of relating measures of the organism's productivity to measures of energy cost, the amount of actual research upon this problem has been very meager. Workers have more or less assumed that diurnal variations in work output are due to natural changes in the level of reactivity. A few have pointed out apparent correlations. Thus Marsh (87) states that the respiration and temperature curves closely parallel the form of the curve for muscular work; but he took no simultaneous records of the two processes. Patrizi (96) did obtain temperature

⁸ It is interesting to note in this connection that Marsh's figures show the highest number of deaths to occur in the late afternoon, when the organism is most active. This is contrary to the popular belief that death occurs most easily when vitality is lowest, as at night.

and muscular output curves for the same subjects, but his readings were taken at such wide intervals (four readings a day) that his positive correlation is not especially significant. Dodge (30) obtained correlative records of pulse and muscular work, and mentions only the similarity of the forms of the curves. Languier des Bancelles (76) and Bergström (11) could find little relationship between pulse rate and the rate of mental processes. Kleitman (70) kept simultaneous records of temperature and muscular performance, reporting that the two paralleled each other closely throughout the day. Lovekin (85) has attempted to combine records of the organism's input and output into a single measure of efficiency. He worked with factory employees, taking as his indicator of energy-expenditure the pulse product (pulse pressure \times pulse rate) and found the per cent of the average energy cost and productivity. His curves,—determined by the formula: $\text{Efficiency} = \frac{\text{output}}{\text{input}}$,—show, in general, an increase in efficiency throughout the day. This is accomplished through a decrease in energy cost and a slight increase in production.

Of all the fields covered by this review, this seems the most promising to one desiring to do further work. True determinations of 'efficiency' can only be achieved when energy cost has been related to productivity.

(IV) FACTORS WHICH AFFECT THE DIURNAL CURVE

While both reactivity and productivity tend to increase throughout the day, the evidence already cited indicates that this course is by no means universal. Study of the factors influencing the diurnal curve has done much to dispel the notion that the organism obeys some mysterious periodic law as invariable and regular as the course of the stars.⁹ Exercise and activity are factors determining to some extent the part of the twenty-four hours which will involve the greatest energy-expenditure. According to Galbraith and Simpson (41), nocturnal birds show temperature curves the exact opposite of those of day birds. By reversing the periods of rest and activity in animals, the same investigators (40) found that the temperature curves could be reversed. These results were later verified on human subjects by Toulouse and Piéron (121), although Polimanti (101) and Völker (124) failed to substantiate the findings. Osborne (92) found that his body temperature varied independently of the point

⁹ Although we do find that Peaks (97) believes in a "cosmic rhythm, which . . . affects all individuals profoundly" (p. 39).

of departure on his travels; this would not have been the case if some 'natural rhythm' were the determining cause of the fluctuation. The literature on the effect of various environmental factors upon physiological processes is so extensive that we cannot review it completely in an article of this kind. Typical references will serve to guide the reader to fuller treatment of the subject-matter.

The importance of muscular and mental activity in determining the form of the curve for the various vital processes can be deduced from the review of the influence of sleep upon bodily activity given in Piéron (99). Muscular work increases temperature (Jürgensen, 67), metabolism (Benedict and Carpenter, 8), and heart action as measured by pulse product (Lovekin, 85), pulse rate (Dill, Talbott, and Edwards, 29, and Henderson, Haggard, and Dolley, 59), and the heart efficiency index (Schneider and Truesdell, 107).

The effect of mental work upon physiological processes is not so clearly established. Day (27) finds a rather pronounced effect while Chappell (22) finds no effect upon blood pressure. Benedict and Benedict (7), after a review of the entire field of previous research and a summary of their own work, come to the conclusion that mental work has some effect upon bodily processes, particularly metabolism, but that the influence is slight.

Food has a very decided influence upon the metabolism, temperature, pulse rate and other physiological processes. Grollman (49) found that pulse rate, blood pressure, and oxygen consumption are increased by food ingestion. Systolic blood pressure is raised (Weyse and Lutz, 130), as is temperature (Pembrey and Nicol, 98, and Benedict and Slack, 10), metabolism (Benedict and Carpenter, 8), and the minute volume of the heart (Collett and Liljestrand, 23). The effects of specific types of food upon metabolism will be found well discussed in the review of Boothby and Sandiford (17). Water also causes increases in metabolism and cardiac output (Grollman, 48).

The effects of exposure to cold are discussed by Barcroft and Verzár (3) and those following exposure to heat by Adolph and Fulton (1). Insensible perspiration is raised by exposure to high temperatures (Wiley and Newburgh, 132). The relation between environmental temperature and skin temperature was studied by Miura (90), while the effect upon other vital processes was investigated by Grollman (52).

The influence of emotions upon blood pressure and heart rate has been studied. The effects of 'psychic' disturbances have been

investigated by Grollman (50), Britton, Hinson and Hall (18), Marston (88), Boas and Goldschmidt (13), and Scott (111). The three first mentioned studies find that blood pressure and pulse rate increase in emotional situations, while the last two could discover no well defined effects. The effect of music upon blood pressure is dependent upon the type of music, according to Hyde and Scalapino (64). An excellent discussion of the many factors of this type which affect circulation is to be found in Rihl (105).

Other factors which have been studied in their effect upon circulatory changes are posture (Franke, 37), bathing (Hill, 61), and tobacco and alcohol (Grollman, 51). It should be mentioned at this point that there is a large amount of clinical evidence which shows that curves vary from the normal form in various diseases (*cf.* Boas and Goldschmidt, 13), but we cannot here review this material.

In contrast to the extensive work on the variation in bodily processes associated with environmental influences, the work on output changes produced by these factors is negligible. Lehmann and Pedersen (78), Lombard (83), and Storey (116) have shown in their studies that dynamometric and ergographic output is raised by physical work and exercise.

The influence of food upon the course of efficiency has been noted by a number of writers. Omitting breakfast has been shown by Römer (129) to decrease subsequent mental output. In an article by Kraepelin¹⁰ (71), the influence of food is described as causing a rapid fall initially, but after that an increase until late afternoon. That the variations in output associated with food are not caused entirely by the food content itself is shown by the work of Hovland (63). He found that a camouflaged barium meal produced variations in output more or less identical with those occurring after a real lunch. Finzi (35) states that meals reduce the speed of all functions, but this report is in contradiction to the majority of the above researches.

Age and sex differences do not alter the form of the diurnal curve, according to Marsh (87) and Gates (42); but women reach their

¹⁰ The usual references given for this statement of Kraepelin are Kraepelin, E., *Zur Hygiene der Arbeit*, *Zsch. f. Psychiat.*, 1898, 25, 593 ff. [*E.g.*, Gates (42) and Peaks (97)], and *Ueber Ermüdungsmessungen*, *Arch. f. d. ges. Psychol.*, 1903, 1, 9-30 [Marsh (37)]. The correct citation is Kraepelin, E., *Ueber psychische Disposition*, *Arch. f. Psychiat.*, 1893, 25, 593-594. His article *Zur Hygiene der Arbeit* appears in *Neue Heidel. Jahrbüch.*, 1896, 6, 222-247.

maximum at an earlier hour than do men, and children theirs still earlier (Marsh).

Considerable work has been done on the influence of external conditions, such as the weather. Lehmann and Pedersen (78) found an inverse relationship between temperature and physical and mental productivity. This finding has been confirmed by Lombard (83) for muscular output and by Schuyten (108) for mental work. Peaks (97) thinks that partly cloudy and cloudy days are superior to clear days for both mental and physical performance, but his results, like those of Kuhnes (72), are unreliable and ambiguous.

The work covered in this section has less importance in itself than as a warning that such conditions as the amount of sleep, food, and exercise will have to be controlled more carefully by those who investigate diurnal variations in the future. Systematic study might well be given to the numerous factors which condition the form of the curve and to the relation between the organism's level of reactivity and its variations in performance. Recent advances in methods of measuring the energy cost or 'input' should greatly facilitate such work.

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THE INFLUENCE OF DISEASE UPON MOTOR DEVELOPMENT DURING CHILDHOOD¹

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In discussions of the motor development of the infant and child, the statement is made frequently to the effect that the sick child is greatly retarded in progress as compared with the well child. It is an impression which has prevailed for years and which is to be found in many of the standard text-books on pediatrics and child psychology of to-day. In searching the literature carefully, however, one is surprised at the lack of precise information on this subject. There are many communications on the relationship of disease to intelligence, but, as far as can be ascertained, remarkably few investigations have been recorded dealing with the influence of disease on the developmental trend and tempo of motor habits during childhood. For the most part, only cursory reference is made to the problem. Holt and Howland (1) state, for example, that: "The physician is often consulted because of backward muscular development, most frequently because the child is late in walking. General malnutrition, or any severe or prolonged illness, may postpone for several months this or any of the other functions mentioned" (p. 23). Or, to refer to the psychological literature, Curti (2) makes the following brief remark: "Growth of structure or development in function may of course be hindered at any stage or stopped entirely, because of environmental factors—diseases, for example" (p. 87). To be sure, from time to time, observations have been recorded dealing with individual case reports, but no generalizations can be drawn from the data which are given.

Recently, Stevenson Smith (3) endeavored to study the problem by using large groups of children in order to ascertain the effect of illness on motor development during the first two years of life. The study was carried out by means of the questionnaire method and was subject, therefore, to the inaccuracies of that mode of investigation. The information was obtained from the parents of some nine hundred

¹ I take great pleasure in thanking Dr. Elizabeth B. Hurlock for her generous coöperation in connection with the preparation of this paper.

pupils of a Seattle grade school and dealt with the age at which the children held up their heads, sat up without back support, cut the first tooth, crept, walked alone, said words in response to seen objects and put two or more words into a phrase. Careful notation was made of the time of occurrence of severe illnesses, such as the contagious diseases of childhood, pneumonia, any dangerous gastrointestinal upset, a major operation or a head operation. From an analysis of the data, Smith concluded that ". . . severe illness preceding the development of any trait reduces the apparent rate of development of that trait to about 88 per cent of what it would have been otherwise. Or, stated differently, the most probable amount by which the age of a developing trait will be increased by severe illness is 14 per cent." The investigator stressed the fact, however, that the data were difficult to interpret, for, ". . . among the sick children some of them had developed any particular trait *before* illness and some *after* illness. Therefore, there will be a preponderance of early-developers among those acquiring the trait before illness and a corresponding preponderance of late-developers among those acquiring the trait after illness."

This aspect of the subject is of importance and merits further consideration. It is well known that the rapidity of development of motor traits is highly correlated with intelligence. Investigations have tended to show that on the average, bright children learn to walk and to talk earlier than dull children. Woodworth (4) states that ". . . the difference is greater in the age of talking than in that of walking" (p. 214). In order to illustrate the point, he presents a composite table derived from the studies of Terman and of Mead, comparing the average ages at which children of varying degrees of intelligence start to talk and to walk. The study by Heaton (5) is also of interest. He reports on an experiment which was undertaken to compare the development of certain structural and functional traits of children of low intelligence with those of children of high intelligence. The results showed that in the groups of average general level of physical development, children who rated high in intelligence tests were distinctly superior to those who rated low. The implications of studies such as the above indicate the importance of ascertaining, at the outset of any study on motor control, the type of child with which one is dealing, and the rapidity with which he acquires and exhibits motor functions.

Some investigations have been carried out on the motor development of premature and immature infants. J. Hess (6) cites two such

studies, one by Wall and another by Ylppö. The former showed that premature infants learned to walk on the average six months later and to talk seven and one-half months later than full-term children, in addition to manifesting more frequently certain speech defects, such as stuttering and stammering. Ylppö showed also that prematurely born infants learned to walk, learned first sounds, and uttered first words on the average of one and one-half years of age, or about six months later than full-term infants. In this connection, however, the observations of Gesell (7) are of especial interest. Emphasizing the importance of maturation, he says that:

" . . . the behavior development of the healthy premature infant tends to remain true to an ordinary course . . . the behavior patterns mature in relatively normal sequence, when chronological age is corrected by discounting the prematurity. A premature post-natal environment or a protracted uterine development is not in itself competent to impose marked deviation on the order of emergence or the form of behavior patterns. The maturational factors retain their potency, unless they suffer actual damage from the complications of premature or post-mature birth " (p. 1068).

Elsewhere, (8) Gesell states that:

" . . . as a point of departure for the discussion of maturation, nothing is more comprehensive than the general stability of the trend and tempo of development, in spite of precocious or postponed displacement by birth. The patterns of genetic sequence insure a basically similar growth career for full-term, pre-term and post-term infants " (p. 276).

The above statements receive support from the work of Mohr and Bartelme (9). These investigators found very little difference in the development of premature children as compared with full-term children, when correction was made for the factor of chronological age. This held true for the time of onset of walking, the beginning of talking, and the learning of bladder control. Smaller prematurely born infants were consistently somewhat later in the development of these traits, but the difference was negligible with correction for chronological age.

Mention should also be made of the study of Nelson (10) on variation in development of motor control among 149 goitrous and non-goitrous adolescent girls attending Maryland high schools. The two groups showed homogeneity with respect to motor control, as measured by the tapping test, dynamometer, steadiness, and motor coördination. No conclusive differences were noted between the groups when the influence of thyroid activity on height, weight, and menstrual functions was considered. Nor was a correlation found

between the degree of thyroid enlargement and motor coördination and tremor. Regardless of the underlying condition of the thyroid gland, inefficiency of motor performance was observed, however, in subjects with rapid pulse and tachycardia, and obvious tremor of the hands. It is also of interest to refer to the work of Borovikov (11) who investigated the motor endowment of children with speech disturbances (logopaths) and of deaf mutes (acupaths). Using the Oseretzky scale, he found that the motor ability of children showing these disorders is less developed than that of normal children of the same ages, a discrepancy which became more pronounced with increasing years.

To be sure, many difficulties may be encountered in endeavoring to analyze studies on the relationship of illness to motor development. The importance of a consideration of intelligence has been already indicated. In addition, however, there are various factors which influence the predisposition and susceptibility of individuals to disease, as well as determine the clinical course and eventual outcome. It would seem opportune, therefore, to inquire into the more important of these factors in order to ascertain whether points of interest might be afforded which would be of value in conducting a study in this field of motor development. Perhaps age plays an important rôle, and it will be found that the normal growth of motor habits may be influenced greatly by diseases occurring at certain age periods in childhood; perhaps sex is of significance and, if it is considered, might help materially in an understanding of the subject; perhaps certain illnesses are more particularly prone to cause abnormal deviation in the development of motor traits, making a knowledge of these diseases of aid in a solution of the problem. These and other factors will be considered in an effort to obtain a broad point of view on the interrelation of motor development and disease.

In passing, however, there are some fundamental phases of the problem which merit brief consideration. Much has been said with reference to the relative importance of maturation and learning in the formation of patterns of human behavior. It is not the purpose of this paper to weigh the evidence for and against each of these factors. It will suffice to indicate that apparently the normal progress of evolution of motor habits is dependent greatly upon the unhampered maturation of the main structural systems of the body, as well as upon the maintenance of their normal functional interrelations. The observations of Scammon (12), Pfister (13), Stiles (14), Shirley (15), Murphy (16), and others (17) serve to emphasize the

significant rôle played by maturation in the development of motor control. It should be borne in mind that the early picture in the development of the child is one of continual growth and change of form until characteristic adult features are assumed. In a discussion of the restricted influence of physical handicap, Gesell (18) states in this connection that: "The organismal concept requires that the organism shall maintain an optimal or normal integrity. The phenomena of maturation suggests the stabilizing and unexpugnable factors which safeguard the basic patterns of growth" (p. 318).

Naturally, the progress of motor development will be conditioned in great degree by the physical and mental equipment with which life is started. In the formation of the human embryo, structural differentiation, instead of proceeding normally to final configuration, may deviate in any stage of folding with the production of anomalous or congenital (19) states of the various organs or systems of the body. The degree of structural defect may be so moderate or mild as to cause little or no disability to the future individual, or it may be so severe as to be incompatible with life. The operation of the factor of heredity (20) is also of importance in determining the future course of events in the development of the foetus and the child. Guyer (21) states aptly that:

"Development is a complex reaction between inherent organization and environment, with organization the predominant, specific factor, and environment a generally directive or permissive factor . . . child constitution . . . is fundamentally the outcome of hereditary trends and potentialities" (p. 618).

Then, too, such factors as diseases and accidents of birth, infection, and conditions interfering with the proper growth and development of the infant, are to be considered in evaluating studies on the relationship of illness to motor development (22).

In an excellent paper dealing with constitutional variation and susceptibility to disease, Wade Brown (23) comments that:

"The conception of disease as a product of a constitution is a heritage from antiquity, based on observation and experience. . . . The importance of such factors as age, sex, race and even individual predisposition was clearly recognized; so were the factors of climate, season and weather . . ." (pp. 106, 107).

Emphasizing the importance of individual and group differences in disease, he adds that:

"Changing conditions of life affect individuals and groups, but as individuals differ in respect to their inherent constitutional equipment they differ also in their reactions to influences of all kinds. Some are capable of immediate and

complete adjustment, others are slow to respond or are incapable of adjustment so that when members of a group are subjected to a change in the conditions of life or are exposed to infection under favorable or unfavorable conditions, the response obtained varies according to the capacities of the individual" (p. 150).

It is also well established that there are definite racial differences in susceptibility to disease. For example, according to Rolleston (24) some diseases are prevalent chiefly in the Hebrew race. The diseases are amaurotic family idiocy, thromboangiitis obliterans, Gaucher's disease, Neiman-Pick's lipoid histiocytosis, diabetes mellitus, pentosuria, obesity and acromegaly. On the other hand, the Hebrew race shows a low incidence of tuberculosis, of alcoholism, and of certain forms of cancer, especially uterine. Other races show similar susceptibility and immunity to certain forms of disease. The prevalence of tuberculosis and syphilis among Negroes and Chinese is worthy of mention, as is the high incidence of rickets among Negro and Italian children living in temperate climates. Poynton (25) has pointed out the rarity of chorea among Negroes and full-blooded Indians.

The intimate relation of age to the morbidity and mortality of disease has always been a subject of great interest. It has long been known that certain diseases tend to occur more commonly at certain age levels than at others. As has been shown by the work of Tisdall, Brown, and Kelly (26) such disorders, for example, as tetany, scurvy, and rickets occur characteristically in the first year of life. Erysipelas is of frequent occurrence in the first two years. Poliomyelitis is encountered more often in patients less than five years of age than in those more than five years, whereas endocarditis, rheumatic fever, and chorea occurs infrequently in patients less than four years of age. Of importance is the problem of the acute respiratory disorders of childhood, particularly with reference to the high morbidity and mortality among children under five years of age (27). The factor of age holds true also for the common communicable diseases of childhood, such as measles, whooping cough, mumps, chicken-pox, scarlet fever and diphtheria. The age incidence of these disorders varies, however, under different conditions. For example, as has been shown by Collins (28), Dyer (29), Godfrey (30), Brownlee (31), and by Zinsser (32) a larger proportion of cases occur in the very early years of life among urban children than among rural children, due probably to greater chance for contact infection in more congested areas. This factor may work to the detriment of the rural children who are exposed to these infections in later life.

The investigations of Tisdall and his collaborators (26) have also served to emphasize sex differences in the incidence of disease. Many diseases occur predominantly in the one sex or the other. In cases of pyloric stenosis, 82 per cent of the patients were males. Pyelitis and primary peritonitis occurred mainly in female children, no less than 75 per cent of the patients with primary peritonitis being of that sex. Endocarditis and chorea occurred more frequently in females, 57 per cent having had endocarditis and 61 per cent chorea, whereas only 40 per cent of the cases of rheumatic fever were found in females. Whooping cough and typhoid fever were the only other diseases which occurred more commonly in females than in males. In passing, mention should be made of the common occurrence of goiter in adolescent girls, a physiological phenomenon closely related to growth. In an earlier study (33) Tisdall found that of 26 cases of Meckel's diverticulum as a cause of intestinal hemorrhage, 25 occurred in male infants. Recently, Bakwin and Bakwin (34) reported that of 136 infants suffering from tetany, a condition often accompanied by convulsions, 68 per cent were of the male sex. As an additional example of sex difference in disease may be cited the work of Bleyer (35). Of 137 children who were afflicted with mongolism, 83 were males and 54 females, the male preponderance being greater than that which is usually noted among mentally defective persons as a group. The ratio was 5.9 to 4.1 for all classes of mentally deficient children and 6.2 to 3.9 for all mongoloid idiots. Bleyer believes that the results suggest that some types of mental defect, mongolism among them, may actually occur more often in males and that sex may be a contributory factor to their occurrence.

The influence of season on disease is also a subject of importance. Madsen (36) has surveyed the seasonal factor in Danish epidemics during the past forty years and found it to conform closely with the seasonal periodicity of other European countries and of North America, with a reversal of the curves in the southern hemispheres to correspond with the reversed seasons. Among spring-autumn infections are found epidemic diarrhea, typhoid fever, and poliomyelitis, whereas among winter-spring diseases are found pneumonia, bronchitis, influenza, cerebrospinal meningitis, encephalitis, scarlet fever, diphtheria, tonsillitis, and acute rheumatism. Measles and whooping cough show no regular seasonal variations. Tisdall and his co-workers (26) noted the more frequent occurrence in the winter and spring months of retropharyngeal abscess, nephritis, erysipelas, primary peritonitis, and acute appendicitis, a fact suggestive of an

association with infections of the upper respiratory tract. Pyelitis, intussusception and pyloric stenosis, on the other hand, were noted more commonly in the summer, suggestive of some connection with gastrointestinal disturbances so prevalent at that period of the year. Tetany occurred mainly during the month of March and poliomyelitis during the summer and early autumn months. As has been stressed by A. F. Hess (37), rickets is essentially a disorder of the fall and winter months.

Closely related to seasonal variation of disease is seasonal fluctuation in growth. According to Holt and Howland (1), after infancy relatively few children maintain a uniform rate of growth throughout the year, even though they may attain the average increase for the year. Nearly all healthy infants manifest irregularities in increase in weight, characterized by periods of rest and of spurt. Gain in weight is greater during the six months from May to November than in the six months from November to May. During the former period there is also a slightly greater increase in the rate of growth in height. In the opinion of Emerson (38), however, seasonal or periodic fluctuation in weight accretion of children is probably an accidental phenomenon and but an expression of unfavorable conditions affecting the child, as during the period of least gain in weight, the fall and winter months, the incidence of acute infections affecting the child is at its height. Whitley (39), evidently having seasonal variation also in mind, states that:

" . . . three important things about the facts of growth are important to remember because of their bearing upon motor ability. One is that increase is not uniform, but that there are periods of spurt and periods of comparative rest. Another is that all parts of the body, bones, muscles, limbs, trunk and the various organs, follow a law of growth of their own, also marked by these accelerations and retardations. The third is that the rapid enlargement of one part may coincide with a resting period for another part. . . . When muscles increase disproportionately a resulting flabbiness is evident. This means that children are continually obliged to readjust their mechanism of control" (p. 55).

Intimately allied with seasonal incidence of disease are the influences of climate on the forms of life and the physiological processes of the living body. Sewall (40) believes that: "A study of the geographical distribution of disease would seem to show that the endemicity of various disorders is based upon the relations of certain physical factors of climate, as temperature and humidity" (p. 490). He cites Huntington's opinion to the effect that there is a fundamental relationship between climatic stimuli and racial civilization and

efficiency. It should be borne in mind, however, that the influences of climate are due in part to the effects of certain infections whose pathogenic agents find a suitable environment for the transmission of disease, and in part to physico-chemical effects. For example, there are the so-called "tropical diseases" which abound in the tropical zones, and the frequent occurrence of rheumatic fever and of acute respiratory ailments in countries situated in the north temperate zones. The incidence of rickets is, on the other hand, dependent greatly on the amount of actual sunshine. A. F. Hess (37) holds that: "In general, a map of the incidence of rickets is the practical equivalent of a map of deficiency of sunlight" (p. 60). An excellent reference on the subject of geographic distribution of disease is to be had in the classic treatise by Hirsch (41).

In considering the influence of the various diseases on motor development, it is evident at the outset that the disorders of infancy and of childhood are far too numerous and their subject matter too wide in scope to permit of detailed systematic analysis. It is necessary, therefore, to adopt a broad point of view and to discuss them in the light of generally accepted principles of medicine. Emphasizing the peculiarities of disease in childhood, Holt and Howland (1) state that:

"In many particulars disease in children differs from that of later life. These differences relate to etiology, pathology, symptomatology, diagnosis and prognosis. The greatest contrast to adult life is presented in infancy and early childhood. After seven years of age, children, in their diseases resemble adults more than they do infants" (p. 27).

It should be borne in mind that diseases in general show a marked tendency to attack certain particular tissues or systems of the body, depending upon the underlying etiologic factor. It follows, then, that the degree of motor retardation caused by any illness will be dependent greatly upon the structural and functional importance of the organ or organs involved, as well as upon the extent, permanency or temporary character of the pathologic changes which are induced. In the infant, for example, with the rapid changes occurring in the form and structure of the nervous system and with the marked instability and irritability of the nervous centers, as well as of the motor, sensory and vasomotor nerves, mild disorders may be sufficient to cause profound and irreparable damage. The permanent character of lesions in certain areas of the central and peripheral nervous systems is well known. In this connection, Gesell (42) believes, however, that:

"When certain areas of the nervous system are actually damaged by disease or injury, maturation cannot make amends, but the maturation of the nervous system seems to proceed toward the optimum in areas unimpaired, even though lacking the stimulus of exercise of the functions controlled by the impaired areas. It is for this reason that certain clinical types of profound motor disability attain none the less considerable approximation to normality in certain patterns of behavior" (p. 315).

It is a well established physiological principle that disuse of any system of the body from one cause or another will make for atrophy of that part. For example, a muscle, if left unused, rapidly weakens and may even undergo atrophy. According to Dashiell (43), the advantages secured by the organism by coördination of its muscles may be reduced to three: strength, speed, and accuracy or precision. In addition, a factor of importance in general motor efficiency is muscular exercise, or as Dashiell puts it: ". . . exercise of striped muscles is a *sine qua non* of effective work by the muscles themselves" (p. 62). Bone may be similarly affected by disuse. This is a common clinical experience in the treatment of fractures. Friedländer and Thierse (44), in experiments on dogs and on rabbits, have studied the effect of inactivity upon growing bone by tightly bandaging the extremity or by sectioning the nerves innervating the limb. They found that the bone became lighter, smaller in size, had an increased water content, and a diminution in the total weight of ash. Roentgenologically, the bone showed signs of atrophy, such as rarefaction of the spongy substance. The greater the period of inactivity, the more marked the changes.

The factors of the severity and duration of disease, as well as of the frequency of illness occurring in any child, are also to be considered. It would be of importance to know whether the disorder was of but brief duration, or whether various complications or sequelae had caused it to go on to chronicity, necessitating, thereby, a prolonged period of convalescence. Often the complications of disease are even of greater moment as far as the child's future welfare is concerned than the original infection. Of course, differentiation must be made between disorders due primarily to inherent developmental defect and physical disability arising from acute or chronic disease or from trauma. The severity and duration of disease are intimately related to the virulence of the organism and the resistance of the host. Zinsser (45) summarizes this fact by stating that:

"The accomplishment of an infection, then, is not determined merely by the fact that a micro-organism of pathogenic species finds lodgement in or upon the

body of a susceptible individual, but it is further necessary that the invading germ shall be capable of maintaining itself, multiplying and functioning within the new environment. An infection, then, or an infectious disease, is the product of two factors, invading germ and invaded subject, each factor itself influenced by a number of secondary modifying circumstances, and both influenced materially by such fortuitous conditions as the number or dose of the infecting bacteria, their path of entrance into the body, and the environmental conditions under which the struggle is maintained" (p. 3).

The frequency of illness occurring in any child should also be borne in mind. It is evident that a child who is prone to frequent periods of illness will be hindered greatly in the development of motor and manipulatory habits. Cowan (46) explains this result as due to the lack of opportunity for development during early illness of the fundamental kinesthetic-motor functions resulting from muscular exercise. In this connection, it might be noted that Aoki (47), in a study of the physical and mental development of some fifty children of school age, found that frequent absence from school due to sickness or other abnormalities due to poor health and weak constitution, showed a significant correlation with first walking.

COMMENT

In the above discussion, an attempt has been made to indicate certain of the more important factors in disease in relation to motor development during infancy and childhood. It is evident that the development of motor traits is subject to the operation of many influences, each of which may induce varying degrees of abnormal deviation during disease. However, the extent to which each of these factors exerts its influence can be determined only by clinical observation and experimental investigation in which conditions are carefully controlled.

The factor of intelligence as related to rapidity of development has already been indicated and stressed by the work of Stevenson Smith (3). In addition, however, there are other aspects of the subject which merit careful analysis. There are the factors of constitution, native endowment, and individual susceptibility and immunity to disease, as well as the factors of race and group differences in disease. It is also important to take account of the age level at which illness occurs before one can ascertain its effect upon motor development, implying therefore a knowledge of the extent to which motor development had progressed at the time when the child was taken ill. Gesell (48) emphasizes the fact that:

"It takes time to grow. Development is profoundly conditioned by duration. . . . One may insist that development is a function of age and that a recognition of the age values of behavior and of the behavior values of age constitutes the first essential for developmental diagnosis" (p. 1056).

Then, too, proper evaluation should be made of the factor of sex in its relation to disease and motor development, as well as of the effects of climate and seasonal variation of disease, the latter in connection with seasonal variation in growth. Finally, there are the influences exerted upon motor development by the various diseases themselves, their severity and duration, the permanency of their effects and their frequency of occurrence in the child, as well as their tendencies to alter adversely the normal course of maturation of the various structural and functional systems of the body.

It should be emphasized that any study dealing with the influence of disease upon motor development should not consider merely isolated episodes of illness in the life of the child. The physical and mental growth of the child is conditioned greatly by time and is subject to marked irregularities in tempo. In the long run, these irregularities show a tendency to correct themselves so that on the average, the periods of remission and acceleration may be properly compensated for by the child. Thus, disease may make for apparent retardation of motor development. If observations are made only about the time of illness, they will fail to take account of the ability of the child to be obedient to the laws of maturation and to compensate for periods of time lost, even though lapse of time without practice may tend to lower the fixation value of a function, or cause a loss in the learning process.

Thus, the study of the relationship of illness to motor development during childhood should deal with the entire span of the child's existence and not merely with a cross section at some one particular period. Such a study, then, could best be carried out by beginning with the newborn infant and observing its motor development over a number of years, both in conditions of health and of disease. Observations should be taken at regular intervals with conditions carefully controlled. In this manner, precise and useful information may be obtained. In dealing with groups of children, moreover, the individual child should not be lost sight of, for, as Teasdall (49) quotes from Dr. Barry of Bath: "It is much more important to know what sort of a patient has a disease than what sort of a disease the patient has" (p. 171).

In conclusion, the following remarks of Gesell (50) are worthy of mention:

" . . . the scientific study of infant behavior becomes an important phase of preventive pediatrics. In spite of its ordered stability, the growth complex is to an undetermined degree alterable. To effect these alterations, the behavior signs of significant deviations must be sought and found early."

"Departures from general health and from optimum nutrition, the onset of disease, the course of illness and of convalescence all tend to express themselves by more or less distinctive behavior signs. . . ."

"Behavior symptoms figure in every syndrome. Diseases do not only show pathologic entity in the anatomic and physiologic sense; they have pathologic entity in the sphere of behavior. Behavior signs, which are correlated with the peculiarities of prodromal, active and resolving phases of disease processes, would yield to exploration. The field is one of importance and great fertility" (p. 1073).

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THE FREE ASSOCIATION TEST AS A MEASURE OF DELINQUENCY—A REPLY

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Because of the importance of the free association technique in many fields of individual and analytical psychology and because some worker in the field might be discouraged from using this technique, I believe that comment on an evaluation of my tentative test of delinquent tendencies may be worthwhile. In the *Journal of Criminal Law and Criminology*, Gilliland and Eberhart¹ report in excellent form on an experiment based on my free association test of delinquent tendencies.²

These writers state that "between 5 and 10 per cent of the papers could not be scored. The reasons were: copying stimulus words, writing responses before the stimulus words were pronounced", etc.³ This per cent of obviously unscorable papers seems high and is considerably larger than I have found in the little work that I have done with the test since 1925.

Admittedly a free association test is difficult to administer, especially in the matter of rapport. In dealing with groups of delinquents rapport is much more difficult to establish than is usual with an average classroom group. Unless good coöperation is established, any test results are of little value. This phase of the whole testing movement has not received the emphasis, either in theory or in practice, which it deserves and which it must have if the best results are to be obtained—whether with educational achievement and mental tests or with tests of more specific factors.

Whether delinquency or potential delinquency can be diagnosed

¹ Gilliland, A. R., and Eberhart, J. C., The Association Test as a Measure of Delinquency. *J. Crim. Law and Criminol.*, 1933, 24, 736-747.

² Laslett, H. R., Preliminary Notes on a Test of Delinquent Tendencies. *J. Delin.*, 1925, 9, 222-230.

³ Where possible, Gilliland and Jordan gave the list of words again individually and obtained a scorable paper.

by means of group tests or not and whether delinquency can be corrected by group methods are questions which cannot be answered at the present time. The whole problem deserves a great deal more of sympathetic and scientific study, especially from a clinical and preventive viewpoint.

Gilliland and Eberhart point out the large disparity of number and selection of free association responses in their study and mine, and mention the possible influences of the lapse of time between the two studies (approximately nine years) and of the geographical distances between the two groups (California and Illinois). There is no question in my mind that the differences in time and geographical location have had a very considerable influence on the associative responses. There are many fads and a constant changing of the slang or patois of the delinquent and near-delinquent. Two other factors have had, without doubt, an extensive influence on the responses given in the two studies. These are the radio and the "talkie": they not only give a wide spread to the idioms of the delinquent but seek and establish fads in these idioms. It is my belief that, while my test of nine years ago may not have separated at all clearly the four groups measured by Gilliland and Eberhart, the method of free association is still the best single method in the diagnosis of delinquency. Such a free association test will, however, have to be brought up to date from time to time.

The writers state: "No test depending largely on vocabulary can be considered exclusively a test of delinquency until it has been demonstrated that the factors of social and economic level are not responsible for the differentiating capacity of the test." This statement is, of course, quite correct but I fail to see that it applies much, if any, more to an association test of delinquency than to any other form of test.

The writers criticized my definition of potential delinquency or of tendencies toward delinquency as being so broad that it "makes validation of any diagnostic test practically impossible". I am not able to agree with this in its entirety. The ultimate purpose of the test was that it be used as an individual diagnostic device for youngsters of the junior high school level who were tending toward delinquency but who might be from families of a sufficiently comfortable economic and social status that they could furnish clinical treatment in this field for their children if they needed it. It was hoped, of course, that its use would be much wider. The validation of a test and the definition of a large section of a large field are not

necessarily of the same scope even though the test is in the field defined.

The correction of delinquency is exceedingly difficult after the unsocial trends of thought and of activity have become habitual or after the youngsters have been detected in or convicted of offenses. Few, if any, people will claim any great amount of reform from "reform schools". At present, prevention of delinquent acts and the reënlising of the youngsters' interest in other lines of thought and activity are not only the best means of correcting these tendencies but are about the only means.

A CORRECTION

In the PSYCHOLOGICAL BULLETIN for July, 1934, p. 532, Professor Thorndike calls us to task for writing a critical article on his theory of learning ("Thorndike's Theory of Learning as Gestalt Psychology", *Psychol. Bull.*, June, 1934, 31, 426-437) without having read or referred to his *The Fundamentals of Learning*. In fairness to ourselves we believe the following facts should be recorded:

First, our article was planned in the summer of 1931, and executed in the summer of 1932. It was sent to the editorial offices of the PSYCHOLOGICAL BULLETIN in December, 1932. Thorndike's *Fundamentals of Learning*, published in 1932, was hence not available to us at the time of writing our article. Consequently we could scarcely have taken it into consideration.

Second, since the completion of our paper *we have read* the book in question. Were we writing today, knowledge of this later book would undoubtedly force us to change many minor points in the paper, but the *core* of the argument would remain as it stands.

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